

IN THE CLAIMS

1           1.   (UNCHANGED)   A method for reducing a precision of an  
2 input datum having precision portion and a loss portion,  
3 comprising:

4           a.   comparing the loss portion to a preselected  
5 threshold value,  $f_t$ ;

6           b.   determining a selectable bias,  $\alpha$ , responsive to the  
7 loss portion being in a defined relation to the preselected  
8 threshold value,  $f_t$ ; and

9           c.   combining the precision portion with  $\alpha$ , creating a  
10 reduced precision datum thereby,

11           wherein  $\alpha$  corresponds to a predetermined characteristic of one  
12 of  $\alpha$ , the input datum, the reduced precision datum, and a  
13 combination thereof.

1           2.   (UNCHANGED)   The method of claim 1, wherein determining  
2 the selectable bias further comprises one of:

3           a.   assigning a first value to  $\alpha$ , responsive to the loss  
4 portion being substantially equal to  $f_t$ ;

5           b.   assigning a second value to  $\alpha$ , responsive to the  
6 loss portion being less than  $f_t$ ; and

7           c.   assigning a third value to  $\alpha$ , responsive to the loss  
8 portion being greater than  $f_t$ .

1           3.   (UNCHANGED)   The method of claim 1, further comprising  
2 determining the selectable bias responsive to a predetermined  
3 characteristic of a plurality of input data relative to a  
4 corresponding plurality of reduced precision data.

1           4.    (UNCHANGED)   The method of claim 1, further comprising  
2   determining the selectable bias responsive to a predetermined  
3   characteristic attributable to reducing the precision of the input  
4   datum.

1           5.    (UNCHANGED)   The method of claim 1, further comprising  
2   determining the selectable bias responsive to the predetermined  
3   characteristic of the selectable bias, the predetermined  
4   characteristic being the mean value of a plurality of selectable  
5   bias values.

1           6.    (UNCHANGED)   The method of claim 2, further comprising  
2   determining the selectable bias responsive to a predetermined  
3   characteristic of a plurality of input data relative to a  
4   corresponding plurality of reduced precision data, and the  
5   predetermined characteristic being attributable to reducing the  
6   precision.

1           7.    (UNCHANGED)   The method of claim 6, wherein the  
2   predetermined characteristic is a predetermined mean error value.

1           8.    (UNCHANGED)   The method of claim 2, further comprising  
2   determining the selectable bias responsive to a predetermined  
3   characteristic of one of input data, a corresponding reduced  
4   precision data, and a combination thereof.

1           9.    (UNCHANGED)   The method of claim 8, wherein the  
2   predetermined characteristic comprises a predetermined statistical  
3   value.

1           10. (UNCHANGED)     The method of claim 4, wherein the  
2     predetermined characteristic comprises a predetermined mean error  
3     value of the plurality of reduced precision data relative to a  
4     corresponding plurality of input data.

1           11. (UNCHANGED)     The method of claim 9, wherein the  
2     predetermined statistical value comprises the mean value of the  
3     reduced precision data relative to a corresponding plurality of  
4     finite-precision fixed point input data.

1           12. (AMENDED)     The method of claim 2, further comprising  
2     assigning a fourth value to  $\alpha$ , responsive to [a] the loss portion  
3     being substantially equal to  $f_t$ , the fourth value being in a  
4     predefined relationship with the first value.

1           13. (UNCHANGED)     The method of claim 12, further comprising  
2     determining the selectable bias responsive to a predetermined  
3     characteristic of input data relative to corresponding reduced  
4     precision data, and the predetermined characteristic being a  
5     preselected mean error value associated therewith.

1           14. (AMENDED)     The method of claim 12, wherein:  
2                 a.     the  $f_t$  is approximately equal to  $0.5_{10}$ ;  
3                 b.     the first value is "1" when the value of the loss  
4     portion substantially equals about  $0.5_{10}$ , the input datum is a  
5     negative-valued datum, with the first value being added to the  
6     precision portion;  
7                 c.     the second value is [zero] "0" when value of the  
8     loss portion is less than about  $0.5_{10}$ ;  
9                 d.     the third value is "1" when the value of the loss  
10    portion is greater than about  $0.5_{10}$ , with the third value being  
11    added to the precision portion;

12 e. the fourth value is "0" when the loss portion  
13 substantially equals about  $0.5_{10}$ , and the input datum is a  
14 positive-valued datum; and

15 f. the preselected mean error value relative to the  
16 input datum and the reduced precision datum is minimized.

1 15. (AMENDED) The method of claim 11, wherein:

2 a.  $f_t$  is substantially equal to  $0.5_{10}$ ;

3 b. the first value is a current first value being  
4 selected to be one of ['1']"1" and ['0']"0" when the value of the  
5 loss portion substantially equals about  $0.5_{10}$ , in a predefined  
6 relationship to a previous first value;

7 c. the second value is [zero] "0" when the loss portion  
8 is less than about  $0.5_{10}$ ; and

9 d. the third value is "1" when the loss portion is  
10 greater than about  $0.5_{10}$ , with the third value is added to the value  
11 of the precision portion.

12 16. (UNCHANGED) The method of claim 14, wherein the  
13 predefined relationship is an alternating relationship.

1 17. (AMENDED) The method of claim 16, wherein the alternating  
2 relationship is a toggle relationship with the current first value  
3 being [zero] "0" if the previous first value was "1", and the  
4 current first value being "1" if the previous first value was  
5 [zero] "0", and wherein the preselected mean error value is  
6 minimized responsive to the alternating relationship.

18. (AMENDED) The method of claim 15, wherein the alternating relationship includes a selectable number of "1's" being interleaved with a selectable number of [zeros] "0's", the mean value of the reduced precision data being responsive to the alternating relationship.

19. (UNCHANGED) The method of claim 2, wherein each of the input datum and the reduced precision datum are represented by two's complement fixed point values.

20. (UNCHANGED) The method of claim 16, wherein the alternating relationship includes a selected pseudorandom sequence of data bits.

21. (AMENDED) A method for rounding a first datum,  $X$ , having precision of  $a$  digits, to a second datum,  $\hat{X}$ , having precision of  $b$  digits, wherein  $a > b$ , first  $b$  digits of  $X$  being a precision portion, and remaining  $a-b$  digits of  $X$  being a loss portion, the method comprising:

a. evaluating the loss portion relative to a preselected rounding threshold value;

b. if the loss portion is substantially equal to the preselected threshold, then defining  $\hat{X}$  substantially according to the equation:

$$\hat{X} = X + 2^{-(b+1)}\alpha,$$

where  $\alpha$  is a selectable bias represented by a rounding digit;

c. if the loss portion is not substantially equal to the preselected threshold, then defining  $\hat{X}$  substantially according to the equation:

$$\hat{X} = X + 2^{-(b+1)}; \text{ and}$$

18 d. eliminating the loss portion of  $\mathbf{X}$ , producing  $\hat{\mathbf{X}}$   
19 thereby.

1 22. (UNCHANGED) The method of claim 21, wherein selectable  
2 bias  $\alpha$  is representative of a predetermined characteristic of one  
3 of  $\mathbf{X}$ ,  $\hat{\mathbf{X}}$ ,  $\alpha$ , and a combination thereof.

1 23. (UNCHANGED) The method of claim 22, wherein the  
2 preselected threshold is substantially equivalent to  $0.5_{10}$ .

3  
4 24. (UNCHANGED) The method of claim 23, wherein the  
5 predetermined characteristic comprises a preselected mean error  
6 value of  $\hat{\mathbf{X}}$  relative to  $\mathbf{X}$ .

1 25. (UNCHANGED) The method of claim 24, wherein the  
2 preselected mean error value,  $E(e)$ , is substantially defined by the  
3 equation:

$$E(e) = 2^{-a}(E(\alpha) - \frac{1}{2}),$$

4  
5 where  $E(\alpha)$  is a mean value of selectable bias  $\alpha$ .

6  
7 26. (UNCHANGED) The method of claim 25 wherein the mean  
8 value of the selectable bias is substantially within the range of

$$0.0 \leq E(\alpha) < 1.0$$

9  
1 27. (UNCHANGED) The method of claim 26, wherein the mean  
2 value of the selectable bias,  $E(\alpha)$ , is approximately equal to  
3 preselected mean error value,  $E(e)$ , and  $E(\alpha)$  is approximately zero.

1        28. (UNCHANGED)    The method of claim 27, wherein the  
2        predetermined characteristic further comprises a preselected error  
3        variance value,  $\sigma_e^2$ , substantially defined by the equation:

$$\sigma_e^2 = \frac{2^{-2b} + 2^{-(2a-1)}}{12}$$

1        29. (UNCHANGED)    The method of claim 28, wherein the rounding  
2        digit is selected from a alternating sequence of digits in the pair  
3        of digits <0,1>.

1        30. (UNCHANGED)    The method of claim 28, wherein the rounding  
2        digit is selected from a pseudorandom sequence of binary digits.

1        31. (AMENDED)    A method for rounding a first two's complement  
2        fixed point datum,  $X$ , having an integer part of  $n$  bits, a  
3        fractional part of  $a$  bits the integer part, and sign bit,  $s_i$ , to  
4        a second two's complement fixed point datum,  $\hat{X}$ , having a fractional  
5        part of  $b$  bits following the radix point, where  $a$  and  $b$  are  
6        representative of the respective precisions of  $X$  and  $\hat{X}$ , and where  
7         $a > b$ , comprising:

8            a.    evaluating the fractional part of  $X$  and defining  $y$   
9            as the most significant bit (MSB) of the  $a$  bits;

10           b.    if the first bit following the radix point of  $X$  is  
11           equal to a "1" bit trailed by  $(a-1)$  [zero] "0" bits, then defining  
12            $\hat{X}$  substantially according to the equation:

$$\hat{X} = n + s_i$$

14           and

15           otherwise, defining  $\hat{X}$  substantially according to the  
16           equation:

$$\hat{X} = n + y$$

18           32. (UNCHANGED)    The method of claim 31, wherein the  
19   occurrence of positive numbers and negative numbers in a plurality  
20   of the datum, X, is substantially equiprobable.

1           33. (UNCHANGED)    A method for rounding signal values,  
2   comprising:  
3           a.   detecting a predetermined state value wherein  
4   rounding is desired; and  
5           b.   rounding the state value according to one of  
6                i.   an alternating round-up/round-down method and  
7                ii. a sign addition round-up/round-down method.

1           34. (UNCHANGED)    An arithmetic device, comprising a bias  
2   generator producing a selectable bias  $\alpha$ , responsive to a  
3   predetermined signal characteristic, the device receiving an input  
4   signal and coupling the selectable bias  $\alpha$  thereto.

1           35. (UNCHANGED)    The arithmetic device of claim 34, further  
2   comprising a combiner coupled to the bias generator, the combiner  
3   receiving and combining the input signal and the selectable bias  $\alpha$ ,  
4   and producing an output signal.

1           36. (UNCHANGED)    The arithmetic device of claim 34 further  
2   comprising wherein the bias generator further comprises a  
3   comparator for comparing the input signal to a preselected  
4   threshold value, the comparator urging the bias generator to  
5   produce the selectable bias  $\alpha$  responsive to the preselected  
6   threshold value.



1           37. (NEW) A computer program product recorded on a computer  
2 readable medium for reducing a precision of an input datum having  
3 a precision portion and a loss portion, comprising:

4           a. computer readable program code which compares the  
5 loss portion to a preselected threshold value,  $f_t$ ;

6           b. computer readable program code which determines a  
7 selectable bias,  $\alpha$ , responsive to the loss portion being in a  
8 defined relation to the preselected threshold value,  $f_t$ ; and

9           c. computer readable program code which combines the  
10 precision portion with  $\alpha$ , creating a reduced precision datum  
11 thereby,

12           wherein  $\alpha$  corresponds to a predetermined characteristic of one  
13 of  $\alpha$ , the input datum, the reduced precision datum, and a  
14 combination thereof.

1           38. (NEW) The computer program product of Claim 37, wherein  
2 the computer readable program code which determines the selectable  
3 bias, further comprises one of:

4           a. computer readable program code which assigns a first  
5 value to  $\alpha$ , responsive to the loss portion being substantially  
6 equal to  $f_t$ ;

7           b. computer readable program code which assigns a  
8 second value to  $\alpha$ , responsive to the loss portion being less than  
9  $f_t$ ; and

10           c. computer readable program code which assigns a third  
11 value to  $\alpha$ , responsive to the loss portion being greater than  $f_t$ .

1           39. (NEW) The computer program product of Claim 37, further  
2 comprising computer readable program code which determines the  
3 selectable bias responsive to a predetermined characteristic of a  
4 plurality of input data relative to a corresponding plurality of  
5 reduced precision data.

1           40. (NEW) The computer program product of Claim 37, further  
2 comprising computer readable program code which determines the  
3 selectable bias responsive to a predetermined characteristic  
4 attributable to reducing the precision of the input datum.

1           41. (NEW) The computer program product of Claim 37, further  
2 comprising computer readable program code which determines the  
3 selectable bias responsive to the predetermined characteristic of  
4 the selectable bias, the predetermined characteristic being the  
5 mean value of a plurality of selectable bias values.

1           42. (NEW) The computer program product of Claim 38, further  
2 comprising computer readable program code which determines the  
3 selectable bias responsive to a predetermined characteristic of a  
4 plurality of input data relative to a corresponding plurality of  
5 reduced precision data, and the predetermined characteristic being  
6 attributable to reducing the precision.

1           43. (NEW) The computer program product of Claim 42, wherein  
2 the predetermined characteristic is a predetermined mean error  
3 value.

1           44. (NEW) The computer program product of Claim 38, further  
2 comprising computer readable program code which determines the  
3 selectable bias responsive to a predetermined characteristic of one  
4 of input data, a corresponding reduced precision data, and a  
5 combination thereof.

1           45. (NEW) The computer program product of Claim 44, wherein  
2 the predetermined characteristic comprises a predetermined  
3 statistical value.

1           46. (NEW) The computer program product of Claim 40, wherein  
2 the predetermined characteristic comprises a predetermined mean  
3 error value of the plurality of reduced precision data relative to  
4 a corresponding plurality of input data.

1           47. (NEW) The computer program product of Claim 45, wherein  
2 the predetermined statistical value comprises the mean value of the  
3 reduced precision data relative to a corresponding plurality of  
4 finite-precision fixed point input data.

1           48. (NEW) The computer program product of Claim 38, further  
2 comprising computer readable program code which assigns a fourth  
3 value to  $\alpha$ , responsive to the loss portion being substantially  
4 equal to  $f_t$ , the fourth value being in a predefined relationship  
5 with the first value.

1           49. (NEW) The computer program product of Claim 48, further  
2 comprising computer readable program code which determines the  
3 selectable bias responsive to a predetermined characteristic of  
4 input data relative to corresponding reduced precision data, and  
5 the predetermined characteristic being a preselected mean error  
6 value associated therewith.

1           50. (NEW) The computer program product of Claim 48, wherein:  
2           a. the  $f_t$  is approximately equal to  $0.5_{10}$ ;  
3           b. the first value is "1" when the value of the loss  
4 portion substantially equals about  $0.5_{10}$ , the input datum is a  
5 negative-valued datum, with the first value being added to the  
6 precision portion;  
7           c. the second value is "0" when value of the loss  
8 portion is less than about  $0.5_{10}$ ;

Application No. 09/735,170

9 d. the third value is "1" when the value of the loss portion  
10 is greater than about  $0.5_{10}$ , with the third value being added to the  
11 precision portion;

12 e. the fourth value is "0" when the loss portion  
13 substantially equals about  $0.5_{10}$ , and the input datum is a  
14 positive-valued datum; and

15 f. the preselected mean error value relative to the input  
16 datum and the reduced precision datum is minimized.

1 51. (NEW) The computer program product of Claim 47, wherein:

2 a.  $f_t$  is substantially equal to  $0.5_{10}$ ;

3 b. the first value is a current first value being  
4 selected to be one of "1" and "0" when the value of the loss  
5 portion substantially equals about  $0.5_{10}$ , in a predefined  
6 relationship to a previous first value;

7 c. the second value is "0" when the loss portion is  
8 less than about  $0.5_{10}$ ; and

9 d. the third value is "1" when the loss portion is  
10 greater than about  $0.5_{10}$ , with the third value is added to the value  
11 of the precision portion.

1 52. (NEW) The computer program product of Claim 50, wherein  
2 the predefined relationship is an alternating relationship.

1 53. (NEW) The computer program product of Claim 52, wherein  
2 the alternating relationship is a toggle relationship with the  
3 current first value being "0" if the previous first value was "1",  
4 and the current first value being "1" if the previous first value  
5 was "0", and wherein the preselected mean error value is minimized  
6 responsive to the alternating relationship.

1           54. (NEW) The computer program product of Claim 57, wherein  
2 the alternating relationship includes a selectable number of "1's"  
3 being interleaved with a selectable number of "0's", the mean value  
4 of the reduced precision data being responsive to the alternating  
5 relationship.

1           55. (NEW) The computer program product of Claim 38, wherein  
2 each of the input datum and the reduced precision datum are  
3 represented by two's complement fixed point values.

1           56. (NEW) The computer program product of Claim 52, wherein  
2 the alternating relationship includes a selected pseudorandom  
3 sequence of data bits.

1           57. (NEW) A computer program product recorded on a computer  
2 readable medium for rounding a first datum,  $X$ , having precision of  
3  $a$  digits, to a second datum,  $\hat{X}$ , having precision of  $b$  digits,  
4 wherein  $a > b$ , first  $b$  digits of  $X$  being a precision portion, and  
5 remaining  $a-b$  digits of  $X$  being a loss portion, comprising:

- 6           a. computer readable program code which evaluates the  
7 loss portion relative to a preselected rounding threshold value;  
8           b. computer readable program code which, if the loss  
9 portion is substantially equal to the preselected threshold, then  
10 defines  $\hat{X}$  according to the equation:

$$\hat{X} = X + 2^{-(b+1)}\alpha,$$

12           where  $\alpha$  is a selectable bias represented by a rounding  
13 digit;

- 14           c. computer readable program code which, if the loss  
15 portion is not substantially equal to the preselected threshold,  
16 then defines  $\hat{X}$  according to the equation:

$$\hat{X} = X + 2^{-(b+1)}; \text{ and}$$

18 d. computer readable program code which eliminates the  
19 loss portion of  $X$ , producing  $\hat{X}$  thereby.

1 58. (NEW) The computer program product of Claim 21, wherein  
2 selectable bias  $\alpha$  is representative of a predetermined  
3 characteristic of one of  $X$ ,  $\hat{X}$ ,  $\alpha$ , and a combination thereof.

1 59. (NEW) The computer program product of Claim 58, wherein  
2 the preselected threshold is substantially equivalent to  $0.5_{10}$ .

1 60. (NEW) The computer program product of Claim 59, wherein  
2 the predetermined characteristic comprises a preselected mean error  
3 value of  $\hat{X}$  relative to  $X$ .

1 61. (NEW) The computer program product of Claim 60, wherein  
2 the preselected mean error value,  $E(e)$ , is substantially defined by  
3 the equation:

$$E(e) = 2^{-a}(E(\alpha) - \frac{1}{2}),$$

4 where  $E(\alpha)$  is a mean value of selectable bias  $\alpha$ .

1 62. (NEW) The computer program product of Claim 61, wherein  
2 the mean value of the selectable bias is substantially within the  
3 range of:

$$0.0 \leq E(\alpha) < 1.0$$

1 63. (NEW) The computer program product of Claim 62, wherein  
2 the mean value of the selectable bias,  $E(\alpha)$ , is approximately equal  
3 to preselected mean error value,  $E(e)$ , and  $E(\alpha)$  is approximately  
4 zero.

64. (NEW) The computer program product of Claim 63, wherein the predetermined characteristic further comprises a preselected error variance value,  $\sigma_e^2$ , substantially defined by the equation:

$$\sigma_e^2 = \frac{2^{-2b} + 2^{-(2a-1)}}{12}$$

65. (NEW) The computer program product of Claim 64, wherein the rounding digit is selected from an alternating sequence of digits in the pair of digits <0,1>.

66. (NEW) The computer program product of Claim 64, wherein the rounding digit is selected from a pseudorandom sequence of binary digits.

67. (NEW) A computer program product recorded on a computer readable medium for rounding a first two's complement fixed point datum,  $X$ , having an integer part of  $n$  bits, a fractional part of  $a$  bits the integer part, and sign bit,  $s_i$ , to a second two's complement fixed point datum,  $\hat{X}$ , having a fractional part of  $b$  bits following the radix point, where  $a$  and  $b$  are representative of the respective precisions of  $X$  and  $\hat{X}$ , and where  $a > b$ , comprising:

a. computer readable program code which evaluates the fractional part of  $X$  and defining  $y$  as the most significant bit (MSB) of the  $a$  bits;

b. computer readable program code which, if the first bit following the radix point of  $X$  is equal to a "1" bit trailed by  $(a-1)$  "0" bits, then defines  $\hat{X}$  substantially according to the equation:

$$\hat{X} = n + s_i$$

and

17 computer readable program code which otherwise defines  $\hat{x}$   
18 substantially according to the equation:

19 
$$\hat{x} = n + y$$

1 68. (NEW) The computer program product of Claim 67, wherein  
2 the occurrence of positive numbers and negative numbers in a  
3 plurality of the datum,  $X$ , is substantially equiprobable.

1 69. (NEW) A computer program product recorded on a computer  
2 readable medium for rounding signal values, comprising:

3 a. computer readable program code which detects a  
4 predetermined state value wherein rounding is desired; and

5 b. computer readable program code which rounds the  
6 state value according to one of

7 i. an alternating round-up/round-down method; and

8 ii. a sign addition round-up/round-down method,

9 wherein the state value corresponds to a selectable bias  
10 value imposed by rounding.

1 70. (NEW) The computer program product of Claim 69, wherein  
2 the selectable bias value is substantially zero.

1 71. (NEW) The computer program product of Claim 69, wherein  
2 the selectable bias value is substantially non-zero.

#### REMARKS

Claims 1-71 are pending in the case. Original Claims 12, 14, 15, 17, 18, 21, and 31 are amended to correct inaccuracies of description and definition, and to secure substantial correspondence between the Specification, the Drawings, and the remainder of the Claims. New Claims 37-71 are fully supported by, and within the scope of, the Specification. No new matter is



Application No. 09/735,170

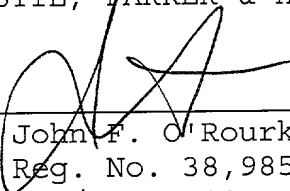
introduced into the Application by the amended Claims or by the new Claims.

Applicants believe that the Claims pending in the case are in condition for allowance, and an early notice of allowability is respectfully solicited. If the Examiner believes that a telephone conference with Applicant's attorney might expedite prosecution of the application, he is invited to call at the telephone number indicated below.

Respectfully submitted,

CHRISTIE, PARKER & HALE, LLP

By

  
John F. O'Rourke  
Reg. No. 38,985  
626/795-9900

JFO/dmm

DMM IRV1042704.1-\*--2/27/01 1:09 PM